INSTITUTO POLITÉCNICO DE BRAGANÇA

CHEMISTRY IS ALL AROUND NETWORK

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# CHEMISTRY TEACHERS' TRAINING IN PORTUGAL

Lifelong Learning Programme

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# CHEMISTRY TEACHERS' TRAINING IN PORTUGAL

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**ABSTRACT**

*This report presents an overview of teacher´s training as considered by the Portuguese legislation: (i) initial teacher education (ITE), (ii) specialized training and (iii) in-service teacher training. Nowadays, ITE corresponds to level 7 of the European Qualifications Framework (master degree). It is a career-long professional development, where research-based and in context practice are important features. Specialized training is intended to provide qualification in complementary educational functions, such as special education, school administration and inspection activities, socio-cultural animation and basic education for adults. In-service training or continuous training allows teachers to complement, deepen and update their knowledge and professional competences. Its accreditation, in what concerns involved institutions, training actions and evaluation process is centralized in the "Conselho Científico-Pedagógico da Formação Contínua" (Scientific and Pedagogical Council of in-service training) and has a direct impact in teacher's careers, being one of the factors considered to access mobility and progression. A special emphasis will be given to training in information and communication technologies (ICT) and to teaching of experimental sciences for primary school. In a last point, the impact of the project "Chemistry is All Around Network" on teacher training is examined. The report presented here reflects the content of the two state of the art papers and the five reviews performed concerning the thematic in focus (teacher training), and the results of the workshop organized with the involved teachers and scientific experts. In summary, the impact of the project on teacher´s training was evaluated positively, contributing unequivocally to strength the cooperation between IPB, CFAE-Bragança and its associated schools, which has positive impacts on the quality and diversity of in-service teaching training actions offered to chemistry teachers.*

## 1. National Situation on Teacher Training

According to the Portuguese legislation [1], teachers' training is organized in three different categories:

(i) Initial teacher (ITE);

(ii) Specialized training;

(iii) In-service training.

ITE corresponds to level 7 of the European Qualifications Framework (master degree). It is a career-long professional development, where research-based and in context practice are important features. Specialized training is intended to provide qualification in complementary education functions, such as special education, school administration and inspection activities, socio-cultural animation and basic education for adults. In-service training or continuous training allows teachers to complement, deepen and update their knowledge and professional competences. In the next two sub-sections ITE and In-service training will be described in more detail reflecting the work performed in the two state of the art papers produced within the context of the present work [2, 3]

### 1.1 Initial Teacher Training

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Presently, and following the Bologna process, ITE programmes in Portugal have been restructured and a Master degree is required to ingress teacher profession (since 2007). ITE curriculum is presently driven to learning outcomes and the valorisation of teacher practice (supervised practice and internship).

In general terms, ITE organization comprises a first cycle, typically of 3 years (180 ECTS) characterized by a broad training in basic education for class teachers and a field of knowledge oriented training for subject teachers (e.g. chemistry, mathematics, biology etc.). Following this first cycle, a master degree is required. The duration of this second cycle is of 1-2 years for class teachers. Table 1 specifies the duration of the second cycle for class teachers according to the target teaching level.

Table1. Duration of the second cycle for class teachers (based on [4]).

| **Teaching level** | **Second cycle duration** |
|---|---|
| Kindergarten or basic education (1st cycle) | 1 year (60 ECTS) |
| Kindergarten and basic education (1st cycle) | 1.5 years (90 ECTS) |
| Basic education (1st and 2nd cycles) | 2 years (120 ECTS) |

Class teacher's education follows a concurrent model being subject and pedagogical subjects taught simultaneously, whereas subject teacher's education follows a consecutive model [4]. For this last case, a second cycle with a typical duration of 1.5-2 years (90-120 ECTS), where professional qualifications are acquired, is needed.

In what concerns chemistry teachers, the formation pattern corresponds to a subject oriented first cycle followed by a second cycle (master) mainly focussed on professional qualifications. The second cycle entitled "Education in Physical-chemistry Sciences" (2 years, 120 ECTS) aims to qualify teachers, both in physics and chemistry sciences, to teach basic (3th cycle) and secondary education levels [6]. To access this second cycle the applicants need to have 120 ECTS in the two subject areas (physics and chemistry) including no less than 50 ECTS in each of them. Examples of the first cycle are Chemistry, Physical-Chemistry Sciences and Biochemistry, among others. The second cycle provides training in physics and chemistry didactics, as well as, in educational psychology being only provided by Universities.

ITE formation can be provided by public (Universities and Polytechnics) and non-public Higher Education Institutions (HEIs). Public HEIs receive governmental funding but students have to pay a fee that varies from 631-1066 euros.

For public HEIs, the access to the first cycle is made at national level and subject to *numerus clausus*, whereas for the second cycle it is made at HEIs level. Requirements for each cycle can be consulted on the website of NARIC (National Academic Recognition Information Centre) [5] and are transcribed below:

First cycle (general regime): National and foreign students wishing to apply must fulfil the following conditions: (i) Have successfully completed a secondary course or a national or foreign qualification legally equivalent; (ii) Have set for the entrance examinations required for the degree programme the student wishes to attend and get the minimal mark required; (iii) Have fulfilled the prerequisites for the higher education course the student wishes to attend, if required.

Besides the general regime there are special conditions for top level athletes, Portuguese citizens on an official mission abroad, national or foreign staff in diplomatic mission, and permanent staff of the Portuguese Armed Forces and scholarship holders within the framework of cooperation agreements signed by Portugal.

Besides the general regime and the special conditions there are also special competitions for applicants with certain specific qualifications thus allowing new publics to accede to higher education in a perspective of lifelong learning, namely: (i) applicants over 23 years old who have passed a especial exam for assessing their capacity to accede to higher education; (ii) holders of a specialization technological course (non-higher education post-secondary course).

Second cycle: Those who meet the following conditions may apply: (i) Holders of a 1st cycle degree or legal equivalent; (ii) Holders of a foreign academic degree dully recognised as satisfying the objectives identical to

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the 1st degree by the competent scientific body of the higher education institution where one wishes to be admitted; (iii) Holders of an academic, scientific or professional curriculum vitae that is recognized as attesting the capacity to carry out this cycle of studies by the statutorily competent scientific body of the higher education institution to which they wish to be admitted.

### 1.2 In-service Teacher

The contents of this section are based on Portuguese legislation/regulations [1, 7-14]. Accordingly, in-service training actions are conducted by training bodies accredited by the CCPFC-Conselho Científico-Pedagógico da Formação Contínua (Scientific and Pedagogical Council of in-service training), headquartered at the University of Minho (Braga, Portugal). Examples of these training bodies are:

(i) Training centers associated with school associations (CFAE);

(ii) Higher education institutions;

(iii) Training centers of professional or scientific non-profit associations;

(iv) Occasionally, the central services of the Ministry of Science and Education;

(v) Other non-profit private or public entities and cooperatives accredited for this purpose.

The formation plans can be drawn by schools considering their own training needs diagnosis or might simply result from an individual initiative of the teacher. Given the current economic situation there is at present no governmental funding to support in-service training.

Although several HEIs are able to offer a wide range of paid formation packages, the search for these actions is decreasing, partly justified by the CFAEs work trying to address the most urgent needs of their associated schools. In this context, free training is being offered thanks to:

(i) Endogenous school resources (some accredited teachers make themselves available to provide training to their colleagues);

(ii) The existence of protocols and partnerships with other entities within the framework of training programs.

Most of the training actions correspond to face-to-face classes; however there is a progressive change of paradigm due the progressive consolidation of ICT use. As so, the online format through e-learning and b-learning modalities is becoming a current practice, not only because of its effectiveness but also as a way to address financial, distance and time constraints. The evaluation of the actions is compulsory and must be accredited by the CCPFC. The final classification is expressed qualitatively (insufficient to excellent) corresponding to a final ranking on a scale comprised between 1 and 10 values. The evaluation accounts with the teacher performance but also with assiduity.

Among other factors, to access progression, teachers must attend, with success, in-service training or specialized training actions during the cycle under evaluation. Specifically, they need to have accredited 25 hours in the fifth step of the teaching career (= 1 credit) and 50 hours in the others (= 2 credits). As so, to access progression, teachers have obligatorily to attend in-service training actions, accredited by CCPFC, up to the required number of hours, irrespective of attending other non-accredited training actions such as colloquia, conferences, seminars or workshops. Moreover, it is mandatory that part (at least 50%) of the attended training lies in actions within the appropriate scientific area.

### 1.3 Teacher training in ICT and experimental sciences

In the past years a strong effort was made by the Portuguese Ministry of Education to modernize schools and reinforce the role of ICT as a basic tool for teaching and learning. Examples of programs at national level are

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the “Minerva project” (1985-1994), the “Nonio-21st Century” (1996-2004), and more recently the “Technological Plan for Education” (approved in September 2007) with the following objectives [15]:

(i) Provide technological infrastructures to schools;

(ii) Make available online contents and services;

(iii) Promote the ICT skills of the schools’ community.

According to this financed program in-service ICT training was provided to teachers. As a result of this investment, a very recent work making a survey in 2011 (over 190 000 online questionnaires posed to students, teachers and head teachers) in several schools across Europe (EU27, Croatia, Iceland, Norway and Turkey) [16] pointed out that the percentage of students that are taught by “digitally confident and supportive teachers” reached 20–25% for the EU average. In Portugal, the values were 30 to 50% for students at 4 and/or 8 grades and more than 45% in grade 11.

Also, in Portugal, a very ambitious National Training Program in Teaching of Experimental Sciences for Primary School Teachers was developed between 2006 and 2010, involving 5141 primary school teachers, 4245 schools and 149359 students [17]. Its impact was huge; it was very well supported by several documents (training plan, training programs, progress reports, final reports, external evaluation reports), publicly available, and though, to our knowledge only in Portuguese. Nevertheless, they can constitute very important sources of information for the development of similar programs in other countries. Another very important output of this training program was the teaching resources developed, including a didactic guide for teachers and a notebook for students to register their observations. A final report is also available that evaluates the impact of this training program [18].

## 2. Assessment of the National Training of Science Teachers

Teacher education is an important issue being teacher quality identified as an important factor to enhance students’ outcomes. From initial teacher training (ITE) to in-service training, the development of a quality culture is important. In what concerns ITE in Portugal, one of the positive aspects arising from the Bologna process implementation seems to be the valorization of the teachers’ socio-professional status based on the assumption of a higher professional qualifications (master degree), a curriculum driven to learning outcomes, and the valorization of teacher practice. Nevertheless, the teaching profession in Portugal is nowadays characterized by a surplus and unemployment among the new teachers. As a consequence, recruiting of student teachers in ITE programs is becoming difficult and a lack of motivation to pursue teaching careers is generally noticed [18]. In what concerns chemistry teachers ITE programs, one negative aspect was the creation of a common 2nd cycle, Education in Physical-chemistry Sciences aiming to support both chemistry and physics professionals. As so, chemistry teachers for basic (3th cycle) and secondary education levels can nowadays proceed from quite different 1st cycles. In this context, in-service training becomes more crucial for teaching in the current Portuguese education context, ensuring teacher’s knowledge update and skills development.

Regardless of career progression, the importance of in-service training must be perceived by all teachers, who need to face training as an intrinsic and essential need. ITE formation by itself is no more enough to support a teaching career. Today, quality standards claim for updated professionals strongly committed with independent learning in a "lifelong learning" concept. Be updated through in-service training participation is an efficient way to respond to the requests of the actual educational system.

One of the positive aspects of in-service training relies on its centralized coordination by CCPFC - Conselho Científico-Pedagógico da Formação Contínua (Scientific and Pedagogical Council of in-service training). CCPFC is responsible for the accreditation system in what concerns the institutions involved, training actions and evaluation process; guarantying homogeneity of criteria at national level. Also a positive point was the creation of the CFAEs – Centros de Formação de Associações de Escolas (Training centers associated with school associations) that work directly with their associated schools trying to solve the most urgent formation needs. Moreover, and facing the present economic situation, where a lack of funding for in-service actions

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exists, CFAEs still offer some free actions due endogenous school resources and the establishment of protocols and partnerships with other institutions.

Following the past national financed actions, e.g. the program dedicated to information and communication technologies (ICT) [15] and the national program focused on the teaching of experimental sciences for primary school [17], the situation is nowadays quite distinct. Teachers have to financially support their in-service formation, e.g. by attending the paid formation offered by some HEIs or other accredited bodies, or take advantage from the CFAEs proposals, which can be limited in some scientific areas.

Considering the thematic "Teacher Training", 5 national publications have been reviewed. These resources were commented by non-national teachers and experts. Table 2 presents the set of selected publications.

(i) In the work of Flores [17], an overview of the initial teacher education (ITE) in Portugal, following the Bologna process, is presented. One of the foreseen positive aspects is the valorization of the teachers' socio-professional status based on the assumption of a higher professional qualifications (Master degree), a curriculum driven to learning outcomes, and the valorization of teacher practice. Nevertheless, in what concerns the ITE curriculum, authors pointed out that it is "marked by fragmentation and a lack of articulation of its key components (mainly professional practice, which tends to be undervalued from an academic cultural stance)". In a socio-economical context, the teaching profession is characterized by a surplus and unemployment among the new teachers. As a consequence, recruiting of student teachers in ITE programs is difficult and a lack of motivation to pursue teaching careers is noticed.

(ii) The work of Pombo et al. [19] presents a very good example of an "in-service professional development platform for teachers to enhance their role in promoting education through science". In particular, it evaluates the adaptation of the existent e-module "Assessment of Children's Learning in Primary Science" (Bradford College, UK) to science teachers in the Portuguese context.

(iii) The main objective of the work of Fortes and Flores [20] was to infer the relationship between teacher collaboration and teacher development at the workplace being concluded that collaborative work can be seen as an important tool for teachers' continuing professional development. As so, these cultures should be encouraged at school by providing to teachers the needed support. As the authors stated "The existence of supportive working conditions for sharing experiences at school is central to enhance teacher motivation and job satisfaction and, therefore, authentic and productive collaborative work".

(iv) An important document evaluating the impact of a very ambitious National Training Program in Teaching Experimental Science for Primary teachers, developed between 2006 and 2010, is the one of Martins et al. [18]. The numbers speak by themselves: 5141 primary school teachers, 4245 schools and 149359 students involved.

(v) In the work of Paiva and Fiolhais [21] a study concerning the use of ICT by teachers (all levels, with the exception of the high education ones) is presented in the context of an initiative of the Ministry of Education - program Nonio-21st Century directed by the Competence Centre "Softsciences" and the Centre for Computational Physics of the University of Coimbra. 19337 teachers were involved in this study performed in 2001/2003 and published in the present form (summary of results) in 2003.

The reviewed publications have received a total of 20 comments from non-national teachers and experts. Moreover, the work originally written in Portuguese received only one comment pointed out that "In order to improve the motivation and raise the interest of students in Chemistry and Environmental Preservation, we should use not only appropriate approaches and methods but also interesting organizational forms and teaching tools". Concerning the work dealing with collaborative work it is pointed out that it presents "no specific suggestion for chemistry teachers", but it encourages "collaborative work for all teachers". Though "collaboration gives advantages in training as well as in teacher professional development" difficulties could derive due "lack of time and working conditions" being restricted to "few formal meetings, in which teachers

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can't discuss their real needs". Concerning the work of Pombo et al. it was stated that "all educators involved in e-learning" should "read this paper to learn how to best implement it".

Table 2. Selected publications and number of comments received.

| Title | Authors | Year | Language | Comments | Reference |
|---|---|---|---|---|---|
| Curriculum of initial teacher education in Portugal: new contexts, old problems | Flores, M.A. | 2011 | EN | 1 | [17] |
| Evaluating an online e-module for Portuguese primary teachers: trainees'perceptions | Pombo, L.; Smith, M.; Abelha, M.; Caixinha, H.; Costa | 2012 | EN | 6 | [19] |
| Teacher collaboration and professional development in the workplace: a study of Portuguese teachers | Forte, A.M., Flores, M.A. | 2013 | EN | 7 | [20] |
| Evaluation of the Impact of the Training Program in Teaching Experimental Science: A nationwide study | Martins, I.P; Vieira, C.T.; Vieira, R.M., Sá, P.; Rodrigues, A.V.; Teixeira, F.; Couceiro, F.; Veiga, M.L.; Neves, C. | 2012 | PT | 1 | [18] |
| The use of Information and Communcation Tecnnologies by Portuguese teachers | Paiva, J., Paiva, J.C., Fiolhais, C. | 2003 | EN | 5 | [21] |

## 3. The Impact of the Project on Teacher Training

In what concerns chemistry teachers, the ITE formation pattern in Portugal is quite wide. From the analysis of the "Chemistry is all around network" workshop participants, base formations (first cycles) on Chemical Engineering, Chemistry, Biochemistry, Physics and Physical-chemistry were registered. Continuous professional development through in-service training was therefore considered fundamental, not only as an actualization tool but also to surpass some existing lacks associated with the base formation. Concerning the specific region of Bragança, teachers pointed out a lack of offer in what concerns experimental chemistry training. In this context, the IPB project team promoted the organization of a training action (Instrumental methods of Analysis in the context of basic and secondary school levels) in cooperation with the CFAE-Bragança. Twenty two teachers have attended this CCPFC accredited formation, among them 60% were not members of the project. Figure 1 shows the experimental classes with two groups of teachers.

Several topics for in-service training actions were focused by the Portuguese teachers involved in the project. Among them, technological subjects such as "environmental chemistry", "food chemistry", "polymer technology" and "cosmetic chemistry" were referred. "Analytical chemistry", particularly, the use of analytical equipment, was also mentioned. Moreover "chemical sensors", "nuclear chemistry" and "green and sustainable chemistry" were pointed out as pertinent topics facing the current "chemistry in context" programs.

Most of the involved teachers have attended ICT related courses but not specific for chemistry teaching. A special emphasis was put on the use of ICT resources and the way they can be connected to experimental activities in the laboratory. It was found interesting to develop orientated guides to support the use of ICT

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resources, either as an introduction to the experimental activity or as a tool to consolidate knowledge. More, it was found important to offer training focusing this duality ICT-experimental activity. Nevertheless these constraints they refer the use of ICT resources to support their teaching activities.

Among the cited resources the most used are:

(i) A Química das coisas (http://www.aquimicadascoisas.org/);

(ii) Casa das Ciências (http://www.casadasciencias.org/);

(iii) Ptable (http://www.ptable.com/);

(iv) Phet (http://phet.colorado.edu/pt/simulations/category/chemistry).

As an extension to the meeting, and as a way to promote the cooperation experts-teachers, Professor Paulo Ribeiro Claro (scientific expert) gave a seminar at Museu Ciência Viva de Bragança (associated partner) open to teachers, students and general public. This activity entitled “The Chemistry of Love” is also one of the thematic of the above mentioned project “The Chemistry of Things”. In the first part, there was a seminar and, after, a discussion with the public about the chemistry involved in this emotion, in particular, about the action of chemicals on the brain.

Figure 2 gives an overview of the Portuguese workshop and the promotional material used to disseminate the seminar given by Professor Paulo Ribeiro Claro at Museu Ciência Viva. During the workshop, the project “A Química das coisas – The Chemistry of things” was presented by Professor Paulo Ribeiro Claro to the teachers. He reported a growing use of this resource as an educational tool, which was not foreseen in its creation. The participant teachers corroborate its value and reported they use it mainly as an introductory motivation element. According to them, its success relies on the fact of being scientifically rigorous and appellative, but short enough not to compromise the time needed to work with students.

(1)

(2)

Figure 1. Course of Instrumental Methods of Analysis organized within the context of the Chemistry is All Around Network project. Work with two groups of teachers ((1) UV-VIS and (2) Melting point determination).

During the current year the network was extended to Associated Schools (one signed and two in progress) and Associated Partners (four signed). Table 3 shows the list of Associated Partners.

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(1)


(2)

Figure 2. Portuguese workshop: (1) Presentation of the project “Chemistry of things” by Professor Paulo Ribeiro Claro and (2) Dissemination of the seminar “Chemistry of love” at Museu Ciência Viva de Bragança.

Table 2. List of Associated Partners that joined the project during 2013.

| Associated partner | Logo | Link |
|---|---|---|
| Câmara Municipal de Bragança (Municipality of Bragança) | Câmara Municipal Bragança | http://www.cm-braganca.pt |
| Centro Ciência Viva de Bragança (Science Centre of Bragança) | Centro Ciência Viva de Bragança | http://braganca.cienciaviva.pt/ |
| Centro de Formação da Associação de Escolas Bragança Norte | cfae Bragança Norte | http://moodlecfaebn.com/joomla16/ |
| FEUP - Institution of higher education and scientific research/LSRE - Research laboratory in the area of Chemical Engineering integrated in FEUP | LSRE LABORATORY OF SEPARATION AND REACTION ENGINEERING | FEUP - www.fe.up.pt<br>LSRE - http://lsre.fe.up.pt/ |

## 4. Conclusions

Presently, and following Bologna process implementation in Portugal, the initial training education corresponds to level 7 of the European Qualifications Framework (master degree). It is a career-long professional

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development, where research-based and in context practice are important features. In particular for chemistry teachers, ITE comprises a first cycle (subject oriented type) followed by a second cycle (master) mainly focussed on professional qualifications.

During professional life, teachers can access in-service training to complement, deepen and update their knowledge and professional competences with a direct impact in their mobility and progression. In Portugal, the continuous teacher's training accreditation, in what concerns involved institutions, training actions and evaluation process is centralized in a Scientific-Pedagogical Council (Conselho Científico-Pedagógico da Formação Contínua)

Regardless the number of credits required for career progression, in-service training is crucial for teaching in the current education context ensuring teacher's knowledge update and skills development. This must be perceived by all teachers who must face training as an intrinsic and essential need to encompass the rapid world's modification with impact on teaching activity. Gone are the days where ITE formation was enough to support a career. Today, quality standards claim for updated professionals strongly committed with independent learning in a "lifelong learning" concept. This is an efficient way to respond to the requests of the actual educational system.

The impact of the Chemistry is All Around network project on teacher´s training was evaluated positively, contributing unequivocally to strength the cooperation between IPB, CFAE-Bragança and its associated schools, which has positive impacts on the quality and diversity of in-service teaching training actions offered to chemistry teachers.

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